
CLAIMS

[Claim(s)]
[Claim 1] In the gate actuation circuit for an insulated-gate mold solid-state-switching component (11) The switching element for turn-ons turned on when carrying out the turn-on of said insulated-gate mold solid-state-switching component (11) (18), The switching element for turn-ofves turned on when carrying out the turn-off of said insulated-gate mold solid-state-switching component (11) (20), It has the 2nd output terminal (12b) for supplying OFF state voltage to the 1st output terminal (12a) and gate electrode concerned for supplying ON state voltage to the gate electrode of said insulated-gate mold solid-state-switching component (11). The direct current voltage supply constituted possible [modification of the level of the ON state voltage outputted from the 1st output terminal (12a) at least] (12), The gate resistance for turn-ons which will be in the condition of having connected between the gate electrodes of the 1st output terminal (12a) of said direct current voltage supply (12), and said insulated-gate mold solid-state-switching component (11) where said switching element for turn-ons (18) is turned on (19), The gate resistance for turn-ofves which will be in the condition of having connected between the gate electrodes of the 2nd output terminal (12b) of said direct current voltage supply (12), and said insulated-gate mold solid-state-switching component (11) where said switching element for turn-ofves (20) is turned on (21), An electrical-potential-difference detection means to detect the gate voltage of said insulated-gate mold solid-state-switching component (11) (22), It is prepared so that said switching element for turn-ons (18) and the switching element for turn-ofves (20) may be made to turn on selectively based on a gate control timing signal. When making the switching element for turn-ons (18) turn on The gate actuation circuit of the solid-state-switching component characterized by having a gate control means (23) to perform control which changes the level of the ON state voltage outputted according to the detection voltage level of a ****** electrical-potential-difference detection means (22) from the 1st output terminal (12a) of said direct current voltage supply (12).
[Claim 2] In the gate actuation circuit of a solid-state-switching component according to claim 1 said gate control means (23) In the condition of having made said switching element for turn-ons (18) turning on At the period which has the gate voltage which said electrical-potential-difference detection means (22) detects between the 1st set point and the 2nd set point of a value higher than this The gate actuation circuit of the solid-state-switching component characterized by performing control to which the level of the ON state voltage outputted from the 1st output terminal (12a) of said direct current voltage supply (12) is reduced temporarily.
[Claim 3] In the gate actuation circuit of a solid-state-switching component according to claim 2 said electrical-potential-difference detection means (22) The gate voltage rate of change of said insulated-gate mold solid-state-switching component (11) is constituted possible [detection of the condition of falling temporarily according to a Miller effect]. Said 2nd set point The gate actuation circuit of the solid-state-switching component characterized by being set as the gate voltage in the event of said electrical-potential-difference detection means (22) detecting temporary decline in said gate voltage rate of change.
[Claim 4] It is the gate actuation circuit of a solid-state-switching component where the gate voltage rate of change of said insulated-gate mold solid-state-switching component (11) is characterized by detecting the condition that said electrical-potential-difference detection means (22) falls temporarily according to a Miller effect in the gate actuation circuit of a solid-state-switching component according to claim 3, based on the differential value of the gate voltage.
[Claim 5] In the gate actuation circuit of a solid-state-switching component according to claim 1 said

gate control means (23) In the condition of having made said switching element for turn-ons (18) turning on Performing control to which the level of the ON state voltage to which only predetermined time amount is outputted from the 1st output terminal (12a) of said direct current voltage supply (12) from the event of the gate voltage which said electrical-potential-difference detection means (22) detects reaching the 1st set point is reduced temporarily The gate actuation circuit of the solid-state-switching component by which it is characterized.

[Claim 6] It is the gate actuation circuit of the solid-state-switching component characterized by ending the control to which the level of the ON state voltage to which said gate control means (23) is outputted in the gate actuation circuit of a solid-state-switching component according to claim 5 from the 1st output terminal (12a) of said direct current voltage supply (12) is reduced temporarily after the load current which flows for said insulated-gate mold solid-state-switching component (11) reaches peak value.

[Claim 7] It is the gate actuation circuit of the solid-state-switching component characterized by setting up said 1st set point in the gate actuation circuit of a solid-state-switching component given in any [claim 2 thru/or] of 6 they are equally to the gate threshold electrical potential difference of said insulated-gate mold solid-state-switching component (11).

[Claim 8] In the gate actuation circuit for an insulated-gate mold solid-state-switching component (11) The switching element for turn-ons turned on when carrying out the turn-on of said insulated-gate mold solid-state-switching component (11) (18), The switching element for turn-ofves turned on when carrying out the turn-off of said insulated-gate mold solid-state-switching component (11) (20), It has the 2nd output terminal (12b) for supplying OFF state voltage to the 1st output terminal (12a) and gate electrode concerned for supplying ON state voltage to the gate electrode of said insulated-gate mold solid-state-switching component (11). The direct current voltage supply constituted possible [modification of the level of the ON state voltage outputted from the 1st output terminal (12a) at least] (12), The gate resistance for turn-ons which will be in the condition of having connected between the gate electrodes of the 1st output terminal (12a) of said direct current voltage supply (12), and said insulated-gate mold solid-state-switching component (11) where said switching element for turn-ons (18) is turned on (19), The gate resistance for turn-ofves which will be in the condition of having connected between the gate electrodes of the 2nd output terminal (12b) of said direct current voltage supply (12), and said insulated-gate mold solid-state-switching component (11) where said switching element for turn-ofves (20) is turned on (21), It is prepared so that said switching element for turn-ons (18) and the switching element for turn-ofves (20) may be made to turn on selectively based on a gate control timing signal. When the switching element for turn-ons (18) is made to turn on The gate actuation circuit of the solid-state-switching component characterized by having a gate control means (25) to perform control only whose predetermined period changes the level of the ON state voltage outputted from the 1st output terminal (12a) of said direct current voltage supply (12) after predetermined time passes since the ON event.

[Claim 9] In the gate actuation circuit of a solid-state-switching component according to claim 8 said gate control means (25) In the condition of having made said switching element for turn-ons (18) turning on The gate actuation circuit of the solid-state-switching component characterized by performing control to which the level of the ON state voltage outputted to the predetermined period after predetermined time passes since the ON event from the 1st output terminal (12a) of said direct current voltage supply (12) is reduced temporarily.

[Claim 10] Said direct current voltage supply (12) are the gate actuation circuits of a solid-state-switching component given in claim 1 thru/or any of 9 they are. [which is characterized by having two or more voltage sources for / said / ON-state-voltage generating (13 14), and the switching element for an electrical-potential-difference change-over (16 17) which switches the level of the ON state voltage outputted from said 1st output terminal (12a) by validating these voltage sources (13 14) selectively]

[Claim 11] In the gate actuation circuit of a solid-state-switching component according to claim 10 Said two or more voltage sources for ON-state-voltage generating (13 14) are made into the condition that output voltage level differs mutually. Said switching element for an electrical-potential-difference change-over (16 17) The gate actuation circuit of the solid-state-switching component characterized by switching the level of said ON state voltage by connecting one of said two or more voltage sources (13 14) to said 1st output terminal (12a).

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the gate actuation circuit for insulated-gate mold solid-state-switching components, such as IGBT and MOSFET.
[0002]
[Problem(s) to be Solved by the Invention] The fundamental example of circuitry of the inverter equipment for an AC motor being driven at variable speed is shown in drawing 5 . In this drawing 5 , three-phase bridge rectifier connection of a total of six solid-state-switching components 2a-2f which consist of IGBT(s) is carried out, and it is constituted, and by switching the output of DC power supply 4 given through a smoothing capacitor 3, the inverter main circuit 1 generates the ac output of an adjustable electrical potential difference and a variable frequency, and supplies it to AC motor 5. On-off control of these solid-state-switching components 2a-2f is carried out in predetermined mode by the gate control signal from the gate control circuit 6, and the rotary flow diodes 7a-7f are connected to each solid-state-switching components 2a-2f at each and juxtaposition.
[0003] In order to switch to the condition of passing a current in the direction shown by the arrow head B, from the condition (condition that the solid-state-switching components 2a and 2d were turned on) that the current is flowing in such circuitry in the direction shown by the arrow head A in drawing 5 While switching the solid-state-switching components 2a and 2d to an OFF state, when switching solid-state-switching component 2b and 2e to an ON state, solid-state-switching component 2b, 2e and rotary flow diode 7a, and the phenomenon in which a current flows rapidly to 7d occur. However, the current which flows rapidly in this way becomes generating of a current surge and a noise, and the cause of buildup of switching loss, and becomes destruction of a solid-state-switching component or rotary flow diode, and the cause of degradation depending on the case.
[0004] On the other hand, while establishing two or more (for example, two pieces) voltage sources for actuation for giving gate voltage to an IGBT component for the purpose of aiming at control of the electrical-potential-difference surge at the time of switching of an IGBT component, and reduction of switching loss, the actuation circuit of the semiconductor device considered as the configuration which establishes the switch means which switches the voltage source for these actuation at the time of the turn-off of an IGBT component is indicated by JP,10-23743,A. However, since the actuation circuit of this semiconductor device is the thing of a configuration of functioning only at the time of the turn-off of a semiconductor device, it cannot cope with the trouble which is generated in circuitry like drawing 5 and which was mentioned above.
[0005] This invention is made in view of the above-mentioned situation, and the object is to offer the gate actuation circuit of a solid-state-switching component where it becomes possible to prolong the component life while being able to reduce switching loss, controlling the current surge at the time of the turn-on of an insulated-gate mold solid-state-switching component, and generating of a noise.
[0006]
[Means for Solving the Problem] In order to attain the above-mentioned object, the means indicated to claim 1 is employable. According to this means, a gate control means (23) comes to make the switching element for turn-ons (18), and the switching element for turn-ofves (20) turn on selectively based on a gate control timing signal. When the switching element for turn-ons (18) is turned on Between the gate electrodes of the 1st output terminal (12a) of direct current voltage supply (12) and an insulated-gate mold solid-state-switching component (11) will be in the condition of having

connected through the gate resistance for turn-ons (19). In response to ON state voltage, the turn-on of the solid-state-switching component (11) concerned is carried out to a gate electrode. Moreover, when the switching element for turn-ofves (20) is turned on, between the gate electrodes of the 2nd output terminal (12b) of direct current voltage supply (12) and an insulated-gate mold solid-state-switching component (11) will be in the condition of having connected through the gate resistance for turn-ofves (21), and the turn-off of the solid-state-switching component (11) concerned will be carried out to a gate electrode in response to OFF state voltage.

[0007] In this case, especially a gate control means (23) comes to perform control which changes the level of the ON state voltage outputted according to the level of the gate voltage of the insulated-gate mold solid-state-switching component (11) which the electrical-potential-difference detection means (22) detected from the 1st output terminal (12a) of said direct current voltage supply (12), when making the switching element for turn-ons (18) turn on. When control that only a predetermined period switches a gate voltage level to a low condition is attained in the process to which is followed, for example, the turn-on of the insulated-gate mold solid-state-switching component (11) is carried out and such control is performed, the charging current which flows to the gate capacitance of the above-mentioned solid-state-switching component (11) is restricted. Consequently, in the above-mentioned period, since lifting of the gate voltage of a solid-state-switching component (11) is suppressed, di/dt (that is, start rate) of the load current which flows for that solid-state-switching component (11) becomes loose. Since it is lost by this that the load current flows rapidly at the time of the turn-on of an insulated-gate mold solid-state-switching component (11), while being able to reduce the switching loss, controlling generating of a current surge and a noise, it becomes useful, when prolonging the life of the solid-state-switching component (11) concerned.

[0008] According to the means according to claim 2, a gate control means (23) When the switching element for turn-ons (18) is made to turn on, only the period which has the level of the gate voltage of the insulated-gate mold solid-state-switching component (11) detected by the electrical-potential-difference detection means (22) between the 1st set point and the 2nd set point It comes to perform control to which the level of the ON state voltage supplied to the gate electrode of the solid-state-switching component (11) is reduced temporarily. For this reason, in the above-mentioned period, lifting of the gate voltage of an insulated-gate mold solid-state-switching component (11) comes to be suppressed. Moreover, only the period set up beforehand can ensure now control which switches a gate voltage level to a low condition when carrying out the turn-on of the solid-state-switching component (11).

[0009] According to each means claim 3 and given in four, it can carry out easily by detecting the gate voltage in the event of gate voltage or gate voltage rate of change falling temporarily detection of whether the gate voltage of an insulated-gate mold solid-state-switching component (11) reached the 2nd set point according to a Miller effect in the turn-on process of the solid-state-switching component (11).

[0010] According to the means according to claim 5, a gate control means (23) Only predetermined time amount from the event of the level of the gate voltage of the insulated-gate mold solid-state-switching component (11) detected by the electrical-potential-difference detection means (22) reaching the 1st set point, when the switching element for turn-ons (18) is made to turn on It comes to perform control to which the level of the ON state voltage supplied to the gate electrode of the solid-state-switching component (11) is reduced temporarily. For this reason, only the period set up beforehand can ensure now control which switches a gate voltage level to a low condition when carrying out the turn-on of the insulated-gate mold solid-state-switching component (11).

[0011] According to the means according to claim 6, a gate control means (23) [when the switching element for turn-ons (18) is made to turn on] The control to which the level of the ON state voltage supplied to the gate electrode of an insulated-gate mold solid-state-switching component (11) is reduced temporarily Since the load current which flows for the solid-state-switching component (11) has composition ended after reaching peak value, generating of a surge can be controlled effectively.

[0012] Since it begins when the gate voltage of the solid-state-switching component (11) rises [the control to which the level of the ON state voltage supplied to the gate electrode of an insulated-gate mold solid-state-switching component (11) is reduced temporarily] on a gate threshold electrical potential difference according to the means according to claim 7 (i.e., when the load current begins to flow for a solid-state-switching component (11)), and it is carried out, the event of the load current beginning to flow can be caught to accuracy. For this reason, it becomes possible to prevent certainly the situation where the load current flows rapidly at the time of the turn-on of an insulated-gate

mold solid-state-switching component (11).
[0013] According to the means according to claim 8, a gate control means (25) comes to make the switching element for turn-ons (18), and the switching element for turn-ofves (20) turn on selectively based on a gate control timing signal. When the switching element for turn-ons (18) is turned on Between the gate electrodes of the 1st output terminal (12a) of direct current voltage supply (12) and an insulated-gate mold solid-state-switching component (11) will be in the condition of having connected through the gate resistance for turn-ons (19). In response to ON state voltage, the turn-on of the solid-state-switching component (11) concerned is carried out to a gate electrode. Moreover, when the switching element for turn-ofves (20) is turned on, between the gate electrodes of the 2nd output terminal (12b) of direct current voltage supply (12) and an insulated-gate mold solid-state-switching component (11) will be in the condition of having connected through the gate resistance for turn-ofves (21), and the turn-off of the solid-state-switching component (11) concerned will be carried out to a gate electrode in response to OFF state voltage.
[0014] In this case, when making the switching element for turn-ons (18) turn on, especially a gate control means (25) comes to perform control only whose predetermined period changes the level of the ON state voltage outputted from the 1st output terminal (12a) of said direct current voltage supply (12), after predetermined time passes since that ON event. When following, for example, carrying out the turn-on of the insulated-gate mold solid-state-switching component (11), and control that only a predetermined period switches the gate voltage level to a low condition is attained and such control is performed, the charging current which flows to the gate capacitance of the above-mentioned solid-state-switching component (11) is restricted. Consequently, in the above-mentioned period, since lifting of the gate voltage of a solid-state-switching component (11) is suppressed, di/dt (that is, start rate) of the load current which flows to this becomes loose. Since it is lost by this that the load current flows rapidly at the time of the turn-on of an insulated-gate mold solid-state-switching component (11), while being able to reduce the switching loss, controlling generating of a current surge and a noise, it becomes useful, when prolonging the life of the solid-state-switching component (11) concerned. Moreover, since it is the configuration of performing level change control of ON state voltage only by time control, the whole circuitry can be simplified.
[0015] According to the means according to claim 9, a gate control means (25) comes to perform control to which the level of the ON state voltage by which only the predetermined period after predetermined time passes since the ON event is supplied to the gate electrode of an insulated-gate mold solid-state-switching component (11) is reduced temporarily, when the switching element for turn-ons (18) is made to turn on. For this reason, in the above-mentioned period, lifting of the gate voltage of a solid-state-switching component (11) comes to be suppressed.
[0016] According to each means claim 10 and given in 11, the level of the ON state voltage outputted from the 1st output terminal (12a) can be easily changed now by controlling the switching element for an electrical-potential-difference change-over (16 17).
[0017]
[Embodiment of the Invention] (Gestalt of the 1st operation) It explains hereafter, referring to drawing 1 thru/or drawing 3 about the 1st example of this invention. In drawing 1 which shows the whole electric configuration, IGBT11 is an insulated-gate mold solid-state-switching component by which the switch-on between collector emitters is controlled by gate voltage impressed to a gate electrode, and shows the capacity Cgc between gate collectors, and the capacity Cge between gate emitters in equal circuit by a diagram.
[0018] Direct current voltage supply 12 are for generating the ON state voltage of the straight polarity for carrying out the turn-on of IGBT11, and the OFF state voltage of the negative polarity for carrying out a turn-off, and have 1st output terminal 12a for an ON-state-voltage output, and 2nd output terminal 12b for an OFF-state-voltage output. In this case, let direct current voltage supply 12 be circuitry as was constituted by two steps possible [modification] and shows the level of the ON state voltage outputted from the 1st output terminal 12a to drawing 2 .
[0019] That is, in drawing 2 , direct current voltage supply 12 are equipped with three voltage sources 13, 14, and 15 and the switching elements 16 and 17 for an electrical-potential-difference change-over by which only one side is turned on selectively, and the voltage sources 13 and 14 at least are made into the condition that the output voltage level differed mutually. And each positive-electrode side edge child is connected according to an individual at 1st output terminal 12a through the switching elements 16 and 17 for an electrical-potential-difference change-over, and, as for these voltage sources 13 and 14, each negative-electrode side edge child is connected to a grand terminal.

Moreover, a negative-electrode side edge child is connected to 2nd output terminal 12b, and, as for a voltage source 15, a positive-electrode side edge child is connected to a grand terminal. In addition, each above-mentioned switching elements 13 and 15 are constituted by solid-state-switching components (FET, bipolar transistor, etc.).

[0020] Thus, if it is in the constituted direct current voltage supply 12 When the electrical potential difference between terminals of each voltage sources 13, 14, and 15 is set to V13, V14, and V15 (V13> V14), respectively, for example, from the 1st output terminal 12a According to the ON state of the switching elements 16 and 17 for an electrical-potential-difference change-over, ON-state-voltage +V13 of straight polarity and either of +V14 are outputted, and it is the OFF state voltage of negative polarity from the 2nd output terminal 12b. - V15 will be outputted.

[0021] On the other hand, between the gate electrodes of the 1st output terminal 12a and IGBT11 of direct current voltage supply 12, the switching element 18 for turn-ons and the gate resistance 19 for turn-ons are connected to a serial, and the switching element 20 for turn-ofves and the gate resistance 21 for turn-ofves are connected to drawing 1 at a serial between the gate electrodes of the 2nd output terminal 12b and IGBT11 of direct current voltage supply 12. In addition, each above-mentioned switching elements 18 and 20 are also constituted by solid-state-switching components (FET, bipolar transistor, etc.). Moreover, the gate resistance 19 for turn-ons and the gate resistance 21 for turn-ofves can also make these serve a double purpose by one resistance.

[0022] The gate voltage detector 22 (equivalent to the electrical-potential-difference detection means as used in the field of this invention) is formed in order to detect the gate voltage of IGBT11, and it has the composition of giving the detection electrical potential difference to a control circuit 23 (equivalent to the gate control means as used in the field of this invention). It generates in the mode in which the gate control timing signal for controlling the on-off condition of IGBT11 was able to be decided beforehand, and the gate signal generating circuit 24 has the composition of giving the gate control timing signal to a control circuit 23.

[0023] While a control circuit 23 makes said switching element 18 for turn-ons, and the switching element 20 for turn-ofves turn on selectively based on the gate timing signal from the gate signal generating circuit 24 When making especially the switching element 18 for turn-ons turn on By making either of the switching elements 16 and 17 for an electrical-potential-difference change-over in said direct current voltage supply 12 turn on selectively based on the detection voltage level of said gate voltage detector 22 It has the composition of performing control which changes the level of the ON state voltage outputted from the 1st output terminal 12a of direct current voltage supply 12.

[0024] In the following, the operation relevant to control of example ****** of the content of control by the above-mentioned control circuit 23 is explained, also referring to the characteristic curve of drawing 3 . In addition, this drawing 3 shows roughly gate voltage Vge of IGBT11, the electrical potential difference Vce between collector emitters, and the change property of collector current Ic (load current).

[0025] A control circuit 23 makes the switching element 18 for turn-ons turn on, when the gate control timing signal from the gate signal generating circuit 24 is what orders it ON of IGBT11. At this time, the switching element 16 for an electrical-potential-difference change-over in direct current voltage supply 12 is turned on beforehand. For this reason, from the 1st output terminal 12a of direct current voltage supply 12, the ON state voltage (=+V13) corresponding to the terminal voltage of a voltage source 13 comes to be outputted, and impression initiation of that ON state voltage is carried out through the gate resistance 19 for turn-ons to the gate electrode of IGBT11 (timing t1 of drawing 3). If gate voltage Vge becomes according to impression of such ON state voltage more than the gate threshold electrical potential difference Vth of IGBT11 (timing t2), while collector current Ic will begin to flow, the collector emitter electrical potential difference Vce begins to fall [come].

[0026] Then, a control circuit 23 makes the switching element 17 for an electrical-potential-difference change-over turn on while it judges the event (timing t3) of gate voltage Vge reaching the 1st set point Vs1 set up beforehand based on the detection electrical potential difference by the gate voltage detector 22 and turns off the switching element 16 for an electrical-potential-difference change-over in direct current voltage supply 12. Thereby, from the 1st output terminal 12a of direct current voltage supply 12, the ON state voltage (=+V14<+V13) corresponding to the terminal voltage of a voltage source 14 comes to be outputted, and it is switched to the condition that the level of the ON state voltage impressed to the gate electrode of IGBT11 fell.

[0027] A control circuit 23 is judged based on the detection electrical potential difference according the event (timing t4) of reaching the 2nd set point Vs2 to which gate voltage Vge was set beforehand

to the gate voltage detector 22 after a change-over of such ON state voltage. In this case, although it can also set up as an absolute value, the 2nd set point Vs2 of the above detects the condition that the rate of change of that gate voltage Vge fell temporarily according to the Miller effect when carrying out the turn-on of IGBT11, based on the detection electrical potential difference by the gate voltage detector 22, and when it changes into such a detection condition, it can also consider it as the configuration judged to be that to which gate voltage Vge reached the 2nd set point Vs2.

[0028] And when it judges that gate voltage Vge reached the 2nd set point Vs2, it is returned to the condition of having turned on the switching element 16 for an electrical-potential-difference change-over in direct current voltage supply 12, and a control circuit 23 is switched from the 1st output terminal 12a so that the ON state voltage (= V13) corresponding to the terminal voltage of a voltage source 13 may be outputted. It returns to the original condition from the condition that the level of the ON state voltage impressed to the gate electrode of IGBT11 fell by this, and considers as the condition (the electrical potential difference Vce between collector emitters is the condition of zero substantially) that the turn-on of IGBT11 was carried out thoroughly eventually.

[0029] If it is in a control circuit 23 next, when the gate control timing signal which orders it OFF of IGBT11 from the gate signal generating circuit 24 is inputted, it replaces with the switching element 18 for turn-ons, and the switching element 20 for turn-ofves is made to turn on. For this reason, from the 2nd output terminal 12a of direct current voltage supply 12, the OFF state voltage (=-V15) of negative polarity comes to be outputted, and impression initiation of that OFF state voltage is carried out through the gate resistance 21 for turn-ofves to the gate electrode of IGBT11 (timing t5 of drawing 3). According to impression of such OFF state voltage, the turn-off of IGBT11 comes to be carried out eventually.

[0030] In short, according to the above-mentioned configuration of this example, effectiveness which is described below is done so. That is, since control that only a predetermined period switches the gate voltage level to a low condition is performed in case the turn-on of IGBT11 is carried out, the charging current which flows in the capacity Cge between gate emitters of the IGBT11 is restricted. Consequently, in the period when the gate voltage level was switched as mentioned above, since lifting of the gate voltage Vge of IGBT11 is suppressed, di/dt (that is, start rate) of collector current Ic (load current) which flows to that IGBT11 becomes loose. Since it is lost by this that collector current Ic flows rapidly at the time of the turn-on of IGBT11, while being able to reduce the switching loss, controlling generating of a current surge and a noise, destruction and degradation of IGBT11 can be prevented and it becomes useful, when prolonging the life. In addition, when rotary flow diode is formed along with IGBT11, destruction and degradation of the rotary flow diode can also be prevented.

[0031] Moreover, since it has the composition of performing control which switches the level of the gate voltage Vge to a low condition based on the detection electrical potential difference of the gate voltage detector 22, the 1st set point Vs1 set up beforehand, and the 2nd set point Vs2 when carrying out the turn-on of IGBT11 as mentioned above, only a predetermined period can ensure the control concerned. In this case, since the 2nd set point VS 2 is set as the gate voltage Vge in the event of the rate of change of gate voltage Vge falling temporarily according to a Miller effect in the turn-on process of IGBT11, it can detect easily whether gate voltage Vge reached the 2nd set point Vs2.

[0032] The direct current voltage supply 12 for generating the ON state voltage impressed to the gate of IGBT11 Since it considers as the configuration equipped with two or more voltage sources 13 and 14 for ON-state-voltage generating, and the switching elements 16 and 17 for an electrical-potential-difference change-over which switch the level of the ON state voltage outputted from the 1st output terminal 12a by validating these voltage sources 13 and 14 selectively The level of the ON state voltage concerned can be easily changed now by controlling the switching elements 16 and 17 for an electrical-potential-difference change-over concerned.

[0033] (Gestalt of the 2nd operation) The 2nd example of this invention is shown in drawing 4 , and only a part which is below different from said 1st example about this is explained. That is, in this 2nd example, while omitting the gate voltage detector 22 (R> drawing 1 1 reference) in the 1st example, it considers as the configuration which replaces with the control circuit 23 in this example, and forms a control circuit 25 (equivalent to the gate control means as used in the field of this invention). While this control circuit 25 makes said switching element 18 for turn-ons, and the switching element 20 for turn-ofves turn on selectively based on the gate timing signal from the gate signal generating circuit 24, when especially the switching element 18 for turn-ons is made to turn on, after

predetermined time passes since that ON event, it has the composition of performing control to which only a predetermined period reduces the level of the ON state voltage outputted from the 1st output terminal 12a of direct current voltage supply 12.

[0034] Thus, control to which only a predetermined period reduces the level of ON state voltage is performed by switching serially the ON state of the switching elements 16 and 17 (refer to drawing 2) for an electrical-potential-difference change-over in direct current voltage supply 12. ON-state-voltage +V13 are specifically outputted by the switching element 16 for an electrical-potential-difference change-over already turned on at the ON event of the switching element 18 for turn-ons. When predetermined time passes after that, replace with the switching element 16 for an electrical-potential-difference change-over, turn on the switching element 17 for an electrical-potential-difference change-over, and ON-state-voltage +V14 are outputted. Furthermore, when predetermined time passes after that, it considers as the condition of having made it returning to the condition of having turned on the switching element 16 for an electrical-potential-difference change-over, and having outputted ON-state-voltage +V13.

[0035] Thus, the same effectiveness as the 1st example can be done so also according to the 2nd constituted example, and especially, since it is the configuration of performing level change control of ON state voltage only by time control according to this 2nd example, simplification of the whole circuitry -- the gate voltage detector 22 becomes unnecessary -- can be realized.

[0036] (Gestalt of other operations) In addition to this, this invention is not limited to each above-mentioned example, and following deformation or escapes are possible for it. In the 1st example, a control circuit 23 the control to which the level of the ON state voltage outputted from the 1st output terminal 12a of direct current voltage supply 12 is reduced temporarily Although the gate voltage Vge which the gate voltage detector 22 detects has composition performed in the period between the 1st set point Vs1 and the 2nd set point Vs2 Only predetermined time amount can also be considered as the configuration which performs control to which the level of the above-mentioned ON state voltage is reduced temporarily from the event of the gate voltage Vge which the gate voltage detector 22 detects reaching the 1st set point Vs1. According to this configuration, only the period set up beforehand can ensure now control which switches a gate voltage level to a low condition when carrying out the turn-on of IGBT11.

[0037] Moreover, in each 1st and 2nd examples, it is good also as a configuration which ends the control to which the level of the ON state voltage outputted from the 1st output terminal 12a of direct current voltage supply 12 is reduced temporarily after the load current (collector current Ic) which flows to IGBT11 reaches peak value, and according to this configuration, generating of a surge can be effectively controlled now.

[0038] According to [in the 1st example it is good also as a configuration which sets the 1st set point Vs1 as a value equal to the gate threshold electrical potential difference Vth of IGBT11, and] this configuration When the control to which the level of the ON state voltage supplied to the gate electrode of IGBT11 is reduced temporarily goes up on the gate threshold electrical potential difference Vth of the IGBT11, That is, since it begins when the load current (collector current Ic) begins to flow to IGBT11, and it is carried out, the event of the load current beginning to flow can be caught to accuracy. Consequently, it becomes possible to prevent certainly the situation where the load current flows rapidly at the time of the turn-on of IGBT11.

[0039] In the 1st example, although the rate of change of the gate voltage Vge of IGBT11 mentioned as an example the configuration which performs detection in the condition of falling temporarily according to a Miller effect, based on the detection electrical potential difference by the gate voltage detector 22, it is good also as a configuration performed based on the differential value of the detection electrical potential difference (gate voltage of IGBT11).

[0040] The configuration of direct current voltage supply 12 is good also as a configuration which switches the level of the ON state voltage outputted from the 1st output terminal 12a by not being restricted to the above-mentioned example and choosing the serial-parallel condition of two or more voltage sources by the switching element for an electrical-potential-difference change-over for example. Moreover, the OFF state voltage outputted from the 2nd output terminal 12b of direct current voltage supply 12 may be the thing of ground potential level, and can make unnecessary the voltage source 15 in direct current voltage supply 12 in this case. Of course, it is applicable also to the actuation circuit of insulated-gate mold solid-state-switching components other than IGBT (for example, MOSFET).

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The electric block diagram showing the 1st example of this invention
[Drawing 2] The circuit diagram of an important section
[Drawing 3] The characteristic curve sheet for operation explanation
[Drawing 4] The drawing 1 equivalent drawing showing the 2nd example of this invention
[Drawing 5] Circuitry drawing of the inverter equipment for explaining a configuration conventionally
[Description of Notations]
11 -- IGBT (insulated-gate mold solid-state-switching component) and 12 -- direct current voltage supply and 12a -- the 1st output terminal and 12b -- the 2nd output terminal, and 13-15 -- a voltage source, and 16 and 17 -- the switching element for an electrical-potential-difference change-over, and 18 -- in the switching element for turn-ons, and 19, the gate resistance for turn-ofves and 22 show 23, and, as for the gate resistance for turn-ons, and 20, a gate voltage detector (electrical-potential-difference detection means) and 25 show a control circuit (gate control means), as for the switching element for turn-ofves, and 21.

[Translation done.]